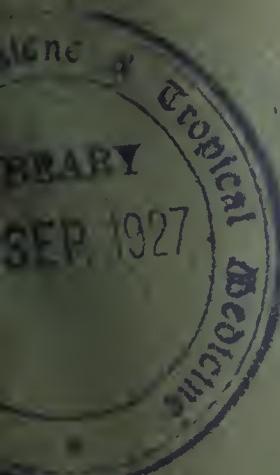


P.5585

1926

ANNUAL REPORT
OF THE
VETERINARY DEPARTMENT,
SUDAN GOVERNMENT.

1926.



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CONTENTS.

SECTION I.

	PAGE.
Diseases of Animals...	2

SECTION II.

External and Internal Trade	9
-----------------------------	---

SECTION III.

Improvement of Livestock	12
--------------------------	----

SECTION IV.

Miscellaneous	14
---------------	----

APPENDIX I.

Report of the Veterinary Research Officer	16
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ANNUAL REPORT.

VETERINARY DEPARTMENT, SUDAN GOVERNMENT,
1926.

STAFF.

During the period under review the following Officers of the Royal Army Veterinary Corps, who were seconded to the Sudan Government, reverted to the British Army on the dates shown :—

Captain R. T. Smith	19th January, 1926.
Major E. G. Turner, D.S.O. ...	17th February, 1926.
Major P. S. Sparling	9th October, 1926.

Captain L. E. Prichard, O.B.E., Veterinary Inspector, resigned his commission in the British Army with effect from 2nd March, 1926, and transferred to the Sudan Government Service.

Mr. A. L. Mullen was appointed Veterinary Inspector with effect from 5th December, 1926.

Mr. E. P. Evans, British Clerk, was invalided out of the service on 30th June and died in August. This official had served for over twelve years in the Veterinary Department during which time he proved himself to be conscientious, hard-working and very reliable. His death is greatly regretted by all members of the Department. Mr. R. C. Garrett was transferred from the Sudan Defence Force on 1st April to replace Mr. Evans.

The establishment of the Veterinary Police Force was increased from one hundred and sixty-one to one hundred and ninety-six non-commissioned officers and men during 1926.

Veterinary Inspectors were stationed in the Provinces of Khartoum, Halfa, Berber, Red Sea, Kassala, Blue Nile, Kordofan and Darfur for varying periods and tours were made in the Provinces of Fung, White Nile, Nuba Mountains, Upper Nile and Bahr-el-Ghazal.

The Assistant Director toured for four months in the Provinces of Kordofan and Darfur. The Director made a short tour in the Bahr-el-Ghazal Province and also visited Malakal, Wad Medani, Wadi Halfa, Kassala, Port Sudan, El Obeid and Nahud at different times during the period covered by this Report.

SECTION I.

DISEASES OF ANIMALS.

I. Diseases of Cattle.

The principal diseases of cattle encountered during the period under review were rinderpest and pleuro-pneumonia. A few outbreaks of foot-and-mouth disease came under notice but none of these assumed serious proportions. The conditions resulting from the partial failure of the rains in many parts of the country in 1925 were such as to favour the spread of contagious and infectious diseases since the scarcity of grazing and water led to the concentration of large herds in certain favoured areas. In many instances when outbreaks came under notice it was found impossible to enforce the usual quarantine measures as these would have resulted in more losses occurring from starvation than were likely to be caused by disease; further, owing to the long distances cattle had to march between the grazing grounds and water the mortality from disease was much higher than it would have been if infection had been contracted under more favourable conditions.

Rinderpest.

Rinderpest may be described as having been widespread throughout the country during the period under review. The heaviest losses from the disease occurred in the Provinces of Fung, Kassala and Kordofan and the only Province that escaped infection was Dongola.

It is impossible to furnish accurate returns for the whole country showing the mortality from this disease but the following figures compiled from reports received from Provinces in which veterinary staffs were stationed give a rough indication of the losses suffered during the past six years and serve for purposes of comparison :—

						Deaths.
1920-21	....	....	....	....	....	3,132
1921-22	....	....	....	....	....	9,143
1922-23	....	....	....	....	....	9,164
1923-24	....	....	....	....	....	6,469
1924-25	....	....	....	....	....	3,757
1925 (last three months)	....	....	....	....	....	489
1926	....	....	....	....	....	8,281

In dealing with the various outbreaks which occurred anti-rinderpest serum, when available, was administered to all the susceptible cattle involved. This resulted in a large expenditure of serum but the expense was justified inasmuch as the mortality was reduced in many cases from fourteen per cent. in untreated herds to approximately two per cent. in treated herds. When serum was used the inoculated cattle were placed in close contact with the sick animals so that they might undergo a mild attack of the disease and so develop a life-long immunity.

A considerable quantity of serum was also used on cattle intended for export to Egypt. Soon after the rains in 1926 large numbers of trade cattle from Darfur congregated at El Obeid. Owing to their numbers and the fact that they were all compelled to water at the same wells in the township it was found to be impossible to prevent contact between these cattle and the local cattle which were infected with rinderpest so that, for several months, cases of the disease occurred in almost every consignment forwarded to Khartoum. In order to meet the requirements of the Egyptian Veterinary Authorities all cattle in infected consignments were quarantined and inoculated with serum before being despatched to Shellal. Steps have been taken to guard against a similar occurrence in future by regulating the number of cattle at any one time awaiting export at El Obeid, by allotting a separate grazing ground and water supply for such cattle and, by a tightening up of tribal disease-control measures, to lessen the risk of the township cattle becoming infected.

Two hundred and fifty-nine deaths from rinderpest occurred in the various quarantine stations during the past fifteen months.

The quantities of serum used during the last two years were as follows :—

	Doses.	Doses.
1925 (a) In the Provinces,	5,242	
(b) In quarantine stations	8,788	—
		14,030
1926 (a) In the Provinces	11,239	
(b) In quarantine stations	12,172	—
		23,411

20,000 doses of serum were obtained from the Veterinary Serum Institute at Asmara in Eritrea in 1926 and the balance was obtained from the Veterinary Serum Institute in Cairo.

Further experiments were conducted at the Veterinary Research Laboratory in connection with the production of anti-rinderpest serum and it is hoped that it will be found possible to establish a small experimental serum station in the near future with a view ultimately to producing the country's serum requirements locally.

Pleuro-Pneumonia.

Outbreaks of contagious bovine pleuro-pneumonia occurred in the Provinces of Bahr-el-Ghazal, Darfur, Kordofan, White Nile and Blue Nile. The losses suffered in the Bahr-el-Ghazal Province during the past two years were reported to be heavy but in the other Provinces referred to the total reported mortality was 224 head, that is, 31 head during the last three months of 1925 and 193 head during the twelve months ending December, 1926. These losses compare favourably with those reported in 1924 and 1925 when they were 811 and 829 respectively. In the various quarantine stations only 69 cases of this disease came under notice during the past fifteen months (32 and 37) as compared with 245 in the previous twelve months. This

improvement is believed to be due largely to a better appreciation of the insidious nature of the disease by native cattle-owners and their consequent greater willingness to slaughter all infected animals. In addition to this the vaccine now produced at the Veterinary Research Laboratory against this disease has given excellent results and is now in great demand. Altogether 4,250 doses of this vaccine were used during the period under review and a considerable amount of work in connection with its production was carried out at the Veterinary Research Laboratory which has resulted in simplifying the method of preparation and in greatly reducing the cost of production.

In previous years heavy losses in the Gezira area, Blue Nile Province, have been attributed to pleuro-pneumonia. During the past two years extensive vaccinations have been carried out in this area and, in the period covered by this Report, only two outbreaks occurred there.

Anthrax.

It is gratifying to be able to record that only three cases of anthrax came under notice in cattle during the past fifteen months; two of these occurred in the old quarantine station at Shambat and the other in the new quarantine station at Khartoum North. As eighty cases occurred during the previous year in the various quarantine stations and most, if not all, were traceable to infection contracted in the Shambat quarantine station the expense of building a new quarantine station has been amply justified by the results.

A Vaccine against this disease was prepared at the Veterinary Research Laboratory but it was not found necessary to use it.

Cases of anthrax in the human subject were reported from the Nuba Mountains Province which has been recognised for some years now as an infected area but no cases were reported as having occurred in cattle.

Foot-and-Mouth Disease.

Outbreaks of foot-and-mouth disease were reported from Darfur, Kordofan, Blue Nile and Red Sea Provinces. The disease was of the usual mild type and the outbreaks did not assume such proportions as to interfere with trade in any way.

Trypanosomiasis.

Seventeen cases of bovine trypanosomiasis were diagnosed at the Veterinary Research Laboratory : fifteen of these were due to *T. congoense* and one to *T. vivax*. Nine of these cases occurred in the Fung Province where the presence of the tse-tse fly is suspected although not yet recorded. It would appear doubtful if the transmission of trypanosomiasis of cattle by blood-sucking flies other than tse-tse is at all common in the Sudan; if it were it is thought that the disease would be more prevalent than it is in Kordofan and Darfur.

Rabies.

Rabies was diagnosed in a calf at El Obeid in March, 1926, and as several persons had drunk the milk of the mother shortly before symptoms of the disease appeared the Medical Authorities took the precaution of giving them anti-rabic treatment.

Tuberculosis.

The comparative freedom from bovine tuberculosis which this country enjoys is something to be thankful for. Only one case has come under notice during the last three years. As a precautionary measure the Government dairy herd were subjected to the tuberculin test about a year ago when all the cows successfully passed the test.

II. Diseases of Camels.

It is impossible at present even to hazard a guess at the annual mortality amongst Arab-owned camels throughout the camel areas of the Sudan but, although this must be considerable from trypanosomiasis, mange and other causes, the survivors apparently more than suffice to meet the owners' meat, milk and transport requirements. The heaviest losses appear to occur in Kordofan and Kassala Provinces but, in spite of that, both these Provinces have a large number of camels surplus to local requirements and some difficulty is being experienced in finding an outlet for them.

The following figures are compiled from returns furnished in connection with camels for which Government forage allowance is drawn. The total number of such camels as at 1st January, 1926, was 1,730, and taking this as an average figure the percentage of loss would be as shown. The figures given include animals cast, lost or stolen as well as deaths from accident and disease :—

PERIOD.	Total losses from all causes.	Losses per cent. per annum.
1920-21	324	18.7
1921-22	299	17.3
1922-23	412	23.8
1923-24	564	32.5
1924-25	491	27.7
1925 (Oct., Nov., Dec.)	130	30.0
1926	385	22.3

Figures supplied by the Military Authorities show that the average losses from all causes in Army camels during the past three years was approximately twenty per cent.

Trypanosomiasis.

The number of claims for compensation for deaths from trypanosomiasis among camels for which forage allowance is drawn were as follows for the periods shown :—

1920-21	131
1921-22	116
1922-23	175
1923-24	226
1924-25	188
1925 (Oct., Nov., Dec.)	51
1926	102

According to these figures the losses from trypanosomiasis up to the end of 1925 averaged forty per cent. of the losses from all causes and during 1926 they only amounted to 26.5 per cent. Practically all the losses from trypanosomiasis occurred in the Provinces of Kassala, the White Nile, Kordofan, Darfur, the Blue Nile and the Red Sea.

An analysis of the returns shows that the biggest decreases were registered in the Provinces of Darfur and Kordofan, the figures for which were as follows :—

PROVINCE.	Period.	Establish- ment of camels	Losses from trypanoso- miasis	Losses from all causes
Darfur	1924–25	?	34	68
	1926	124	11	46
Kordofan	1924–25	?	72	169
	1926	341	17	80

Between November, 1925, and March, 1926, practically all the camels belonging to Government officials and employees in Kordofan Province received a dose of the German proprietary drug which is now sold under the name of "Naganol" and, during the year, ten camels in Darfur Province were similarly treated. It is therefore reasonable to assume that at any rate in Kordofan Province the use of this drug exercised a considerable effect in reducing the mortality from trypanosomiasis.

The following figures showing the losses from trypanosomiasis in Army camels as compared with the losses from all causes during the past three years have been kindly supplied by the Military Authorities.

PROVINCE.	Period.	Losses from all causes	Losses from trypanoso- miasis	Percentage
Darfur	1923–24	73	28	38.4
	1924–25	55	27	49.1
	1925–26*	48	22	45.8
Kordofan	1923–24	151	61	33.1
	1924–25	224	62	28.0
	1925–26*	75	10	13.3
Kassala	1923–24	77	43	55.8
	1924–25	98	44	44.9
	1925–26 *	78	26	33.3

* Covers the period from 1.10.1925 to 31.12.1926.

Towards the end of 1925 a total of 244 Army camels (165 in Kordofan and 79 in Kassala Province) were treated with "Naganol" and the marked decreases in the mortality recorded in these two Provinces for the period 1925–26 are attributable to the beneficial effects of this treatment.

The experiments which have been carried out during the past two years in connection with the treatment of camel trypanosomiasis and the use of the "formol-gel" test in the diagnosis of the disease, have produced results of considerable value to the Government and reflect great credit on the staff of the Veterinary Research Laboratory.

As mentioned in a previous report the native camel-owner usually avoids the risk of severe losses from trypanosomiasis by keeping his camels out of the fly zones during and for some time after the rains but the camels belonging to Government officials and employees frequently have to remain in the fly zones during the dangerous period and this also applies to Army camels, particularly when a military emergency arises. The application of the above-mentioned test and treatment to Army camels now presents no great difficulty and should result in a considerable economy to the Government. In regard to their application to Police and other camels, however, certain difficulties exist but it is hoped that it will be found possible in the near future to evolve a routine system of treatment applicable at least to many of the Police camels.

Rabies.

One case of rabies was diagnosed in a camel at El Obeid, Kordofan Province, early in 1926.

III. Diseases of Equines.

During the period under report 181 horses, 129 mules, and 53 donkeys, the property of Government officials and employees, died or were destroyed. Of these, 41 horses and 52 mules were reported to have died of horse-sickness, 15 horses and 17 mules were destroyed on account of epizootic lymphangitis and 9 horses and 6 mules died of trypanosomiasis.

The losses from all causes during the last twelve months represent fourteen and a half per cent. of horses, sixteen and a half per cent. of mules and six per cent. of donkeys for which forage allowance was drawn.

Horse-Sickness.

It is reported from the Provinces that the losses from horse-sickness were very much less than usual and this is attributed to the comparatively small rainfall. The losses recorded above from this disease were confined mostly to the Provinces of Nuba Mountains and The Fung where the rainfall was comparatively normal.

The only other feature of interest in connection with this disease was an outbreak which was reported at Hassa in Berker Province where five horses out of ten died in October, 1926. Hassa is situated on the railway line approximately eighteen degrees North and this is the first outbreak recorded in this country so far North.

Epizootic Lymphangitis.

Sixty-three pus smears from suspected cases of epizootic lymphangitis were positively diagnosed at the Laboratory during the period under report. The majority of these cases occurred in the Provinces of The Fung, Khartoum and Blue Nile.

Ulcerative Cellulitis (Ulcerative Lymphangitis).

Ulcerative cellulitis was diagnosed in ten pus smears forwarded to the Laboratory, and from reports received from Kordofan and Darfur

it is feared that this condition is much more prevalent in the horse-breeding areas of these Provinces than was formerly suspected. Further information is being collected on this subject.

Trypanosomiasis.

Cases of trypanosomiasis were reported in horses and mules from the Provinces of Upper Nile and Nuba Mountains.

Rabies.

One case of suspected rabies in a horse was reported as having occurred at Abu Zabad, Kordofan Province, in the middle of December, 1925, and another case occurred in a donkey at El Obeid in February, 1926. In the latter case the diagnosis was confirmed at the Laboratory.

IV. Diseases of Sheep and Goats.

Only one case of anthrax in sheep came under notice during the period under review as compared with eight cases in the year previous. A few cases of sheep-pox occurred in animals exported to Egypt and, as a result, 74 sheep were slaughtered at Shellal by the Egyptian Veterinary Authorities.

Losses from sarcoptic scabies and contagious pleuro-pneumonia of the goat were reported in certain districts.

V. Diseases of Dogs.

The outbreak of rabies mentioned in the report for the year ending 30th September, 1925, as having spread from Darfur to South-Western Kordofan was not apparently completely suppressed as a case of rabies in a horse, diagnosed on clinical grounds, came under notice at Abu Zabad on 14th December, 1925. Early in February, 1926, a native policeman who had been bitten by a dog at Nahud about a month previously was admitted to hospital at El Obeid and died shortly afterwards, showing clinical symptoms of rabies. At the same time several cases of suspected rabies in dogs were reported from the same neighbourhood and it was decided to enforce the provisions of the Prevention of Rabies Ordinance without delay. A positive diagnosis of the disease was made at different times from material supplied from a dog, a donkey, a calf and a camel, all from Kordofan Province, but, owing to the prompt action of the authorities, no positive cases occurred outside that Province although suspicious cases were reported from the adjoining Provinces of Nuba Mountains and White Nile. The measures adopted consisted of the destruction of all dogs which were infected or suspected of being infected with the disease, the destruction of all dogs not kept under proper control, the enforcement of muzzling regulations in certain areas and the prohibition of transport of dogs by rail, ferry or steamer except under permit. A pamphlet in Arabic and English describing the symptoms of the disease and outlining the measures to be adopted in the event of an outbreak occurring was widely circulated. By the end of March the outbreak appeared to have been suppressed and no further cases have been reported from the Western Sudan up to date. In the course of this outbreak forty-four persons underwent anti-rabic treatment.

Rabies was reported to be existent in Eritrea in 1925 and a suspected case of the disease occurred in a dog in Kassala in November, 1926. Steps were immediately taken to destroy all stray dogs in the vicinity and no further developments have occurred.

It is estimated that well over 3,000 ownerless or stray dogs were destroyed throughout the country during the year.

SECTION II.

EXTERNAL AND INTERNAL TRADE.

I. Export Trade.

Cattle and Sheep.

The total numbers of cattle and sheep exported during the period under review were 21,881 cattle and 35,685 sheep. The figures for the past six years are as follows :--

			Cattle.	Sheep.
1921	....	....	16,790	53,508
1922	....	....	16,374	21,171
1923	....	....	16,382	39,179
1924	....	....	12,122	25,122
1925	....	....	19,041	30,870
1926	....	....	15,884	19,073

The large decrease in the number of cattle and sheep exported in 1926 as compared with 1925 was mainly due to the demand for meat in Egypt falling considerably below normal presumably through the slump in cotton prices having reduced the purchasing power of the people. A contributory cause in the case of cattle was the temporary failure of supplies from El Obeid during the months of May, June and July due to shortage of water and grazing on the Darfur route. It is hoped that arrangements can be made for adequate supplies of cattle to be forthcoming in future from the Southern areas of the Sudan to tide over the slack period from April to July when few cattle in good condition are obtainable North of the twelfth parallel. As mentioned previously rinderpest was prevalent among cattle intended for export during several months in 1926 but this did not seriously interfere with the flow of trade although the losses suffered by the cattle merchants were considerable and the presence of the disease involved the expenditure of a large quantity of serum. Prices of cattle were well maintained locally during the first half of 1926 but fell considerably towards the end of the year. The past year may be described as having been an exceptionally bad one from the cattle merchants' point of view.

In regard to the sheep trade the large decrease in sheep exports in recent years is shown by the fact that the average annual export of sheep during the four years 1917 to 1920 inclusive was over 163,000 head whereas it was only about 28,500 head during the past four years. This decrease has been attributed to a steady influx of large numbers of sheep from Syria and Tripoli to Egypt which has caused the prices to fall to such an extent that it is now only profitable to market Sudanese sheep there at a certain season of the year.

There is no record of any heavy mortality having occurred among sheep in this country in recent years and, with the large decrease in the numbers exported, it might be concluded that there must now be a large surplus of sheep and that local values must have fallen considerably in consequence. This, however, does not appear to be the case and, if the years when war prices obtained are ignored, it will be found that local prices have not varied to any appreciable extent over a considerable period. It may therefore be assumed that there is a good market for mutton in the Sudan at a certain price and this assumption is borne out by figures which are given later on in connection with the export trade in skins.

During the last three months of 1925, the number of cattle imported from French Equatorial Africa, Eritrea and Abyssinia was 2,274 head. The figures for the years 1925 and 1926 are as follows :—

		1925.	1926.
French Equatorial Africa	....	4,138	3,331
Eritrea	....	1,229	756
Abyssinia	....	5,177	3,971
TOTALS	....	10,544	8,058

It is considered worthy of mention that 66 and a half tons of dried meat, valued at £E. 10,666, were exported in 1926 as against 44 tons, valued at £E. 6,700., in 1925.

Camels.

As in the case of cattle and sheep the export trade in camels to Egypt suffered on account of the depression in the cotton industry. The number of camels exported overland is estimated to have been 6,176 head during the last three months in 1925 and about 6,000 head during 1926 as compared with 9,611 in 1924-25. The camels exported are mainly drawn from Kassala Province and most of them are slaughtered for food in Upper Egypt. Some seventy camels were sent from the Kababish country this year but it is understood the owner was very disappointed with the poor prices they fetched.

Hides and skins.

The quantity of hides exported in 1913 was 403 tons and the average annual export for the seven years 1914 to 1920 inclusive was over 930 tons. A serious slump occurred in 1921 when the exports fell to 39 and a half tons and in order to assist the trade the Railway surtax on hides and skins was reduced from 100 per cent. to 50 per cent. in that year. During 1922, 1923 and 1924 the exports were 146 tons, 187 tons and 358 tons respectively and, with the abolition of the Railway surtax in August 1924, they rose to 462 tons in 1925. With a view to helping the trade still further the veterinary inspection fees were waived in May of this year.

It has been suggested that the number of hides exported depends largely on the mortality among cattle from disease throughout the country but this is not thought to be the case for, when cattle die of disease, the hides are rarely removed before the carcases have commenced to putrefy, they are usually badly flayed and, in consequence, are seldom purchased for export.

During the first half of 1926 there was a good general demand for hides but during the second half the demand was limited to good quality dry-salted hides and as "Fashoda" or "flint-dry" hides were not in request the exports fell off considerably.

The following figures, showing the exports of hides and skins and their value for the last five years, have been extracted from the Customs returns :—

	Hides. Tons.	Skins. Tons	Total Value. £E.				
			1922	1923	1924	1925	1926
1922	146	538	58,900		
1923	187	531	73,075		
1924	358	426	62,052		
1925	462	601	98,714		
1926	428	821	126,431		

The number of sheepskins exported in 1926 was 654,663 which constitutes a record and if to this figure is added the number of sheep exported during the year a total of 673,736 is obtained. When the figures for the last fifteen years are combined in the same way it is found that the average total is 429,946 per annum and, in the best of these years which was 1919, the combined total was only 593,570.

Merchants in the trade state that the large export of skins this year was entirely due to the American demand for skins of high quality.

It is estimated that of the total numbers of skins exported only seven or eight per cent. were goat skins.

II. INTERNAL TRADE.

Local Livestock Requirements.

The numbers of animals slaughtered for human food in the towns of Khartoum, Khartoum North, Omdurman, Wad Medani, El Obeid, Gedaref, Kassala, Wadi Halfa, Atbara and Port Sudan were as follows for the periods shown :—

	1924-25.	Oct., Nov., and Dec.	1926.
		1925.	
Cattle	22,900	6,431 21,035
Sheep	138,200	48,839 180,509
Goats	11,000	1,145 8,489
Camels	1,830	232 1,911

Valuing Cattle at £E. 2,500 m/ms. per head, Sheep at 700 m/ms., Goats at 250 m/ms. and Camels at £E. 2,500 m/ms. the total values of the animals shown above would be as follows :—

	£E.
1924-25	161,315
1925 (last three months)	51,130
1926	185,842

No difficulty has been experienced in obtaining sufficient camels for transport purposes and at the end of 1926 some 1,200 camels were employed in transporting the cotton crop of the Nuba Mountains Province.

Importation of Animals.

Apart from the importation of cattle from neighbouring territories which was referred to in discussing the export trade, the only importations of interest from an economic point of view were Abyssinian mules. In February and March, 1926, some 189 mules were purchased by this Department at Gallabat at an average price of £E. 6 per head.

SECTION III.

IMPROVEMENT OF LIVESTOCK.

Cattle.

It is regretted that, owing to the general scarcity of grazing and water in the central area of the Sudan, it was not found possible to hold cattle shows in 1925 or 1926. It is considered that by holding such shows the value of using carefully selected bulls would be demonstrated and the practice of doing so would be encouraged more effectively than by any other means at the Government's disposal.

The selected bulls which were sold in Kassala last year are reported to have done well and the owners appear to be very pleased with them.

The estimate given in last year's report of the average live weight of bullocks exported to Egypt appears to have been a low one. Batches of one hundred head of average export bullocks were weighed at quarterly intervals at Wadi Halfa during 1925 and 1926 when the highest weight recorded was 1,270 lbs., the lowest was 660 lbs. and the average was found to be 890 lbs.

A young Shorthorn bull, purchased by the Government from the Duke of Westminster's herd, was imported in October, 1925, and makes a very welcome addition to the dairy herd at Khartoum North. This bull and a Friesian bull kindly loaned by the American Mission at Gereif have so far bred nineteen heifer calves and twenty-four bull calves but, of the latter, only two are being retained in the herd. When the dairy herd was first started it consisted entirely of native cows and the average annual milk yield was little over 100 gallons per cow. A considerable amount of Egyptian blood and some Shorthorn blood has been introduced since then and the following statement will indicate the improvement that has taken place :—

Calendar Year.	No. of cows in milk.	Quantity of milk produced. Galls.	Average daily Yield per cow. Galls.
1925	56	10,264
1926	49	11,002

Only those cows whose milking period fell within the calendar year are shown above and the daily yield has been averaged over the milking period.

The improvement in the milk yield for 1926 is attributable to the disposal of unprofitable animals and to some improvement in feeding methods. When the progeny of the pure-bred bulls enter the milking herd a very marked improvement in the milk yield should result.

Horses.

During the period under review considerable progress has been made in connection with horse-breeding, particularly in Darfur Province. A scheme which involved the provision of thirty Arab stallions for use chiefly in the Provinces of Darfur and Kordofan was approved and the purchase of the necessary additional stallions is being carried out. The scheme is briefly as follows:— At the horse shows which are held annually certain selected mares are registered and tattooed on the upper gum for identification purposes. Approved stallions, privately owned, are also registered and tattooed. Careful records of all services by Government and approved stallions will be kept, certificates of service issued, and registered mares will be exempted from herd tax on the production of such certificates. Approved stallions and all geldings are also exempted from herd tax, the latter with a view to encouraging the castration of horses unsuitable for breeding purposes. This scheme has already met with great success in Darfur and it is hoped that within a short period it will be as keenly supported in Kordofan.

It will be obvious that a scheme of this nature involves a considerable amount of work and close supervision if it is to be carried to a successful conclusion and, owing to the small veterinary staff available in the Provinces mentioned, it would be impossible for it to carry out the necessary duties without assistance. Fortunately the scheme has met with the warm approval of the Province officials concerned and with the whole-hearted support which they and the tribal chiefs are giving it there is every prospect of good results being obtained.

At the horse shows held last Winter, 194 selected mares and five approved sires were registered in Kordofan Province and 676 selected mares and 24 approved sires were registered in Darfur.

In Khartoum and Berber Provinces the horse-breeding industry received a rather severe set-back owing to the partial failure of the rains in 1925 and the consequent scarcity of forage.

The Government now possesses the following stallions:— One English thoroughbred, one Egyptian country-bred, sixteen Arab and two Syrian-Arab stallions. The English thoroughbred stallion, ten of the Arab stallions and one of the Syrian-Arab stallions were purchased during the year and two Arab stallions, "Greyhound" and "Mischief," were very kindly presented to the Department by Major J. W. Hornby, M.C., late Commandant, Cavalry and Mounted Rifles, Shendi, and Captain H. G. B. Fergusson, of Ramleh, Egypt, respectively. "Sawari," a Syrian-Arab, was presented to the Nasir of the Rizeigat early in 1926.

Seven stallions were stationed in Darfur and served 214 registered and 73 unregistered mares. During the same period Province stallions served 133 registered and 37 unregistered mares. Three additional stallions were recently transferred to Darfur.

In Kordofan Province three stallions served 135 mares and two more stallions have been sent there.

In Khartoum and Berber Provinces 120 mares were served by Government stallions.

Camels.

A tribal gathering was held at Salala in the Red Sea Province in February, 1926, and as it is intended to make this an annual event; arrangements were made to hold a camel show at the same time. The numbers of camels which competed for prizes were rather disappointing but when the purpose of the show was understood by the people who attended they became so keenly interested that there is every prospect of big entries for future shows.

Poultry.

A pen of pure-bred White Wyandottes and a cockerel of the same breed were imported from England by private individuals during the year. An attempt is being made to improve the breed of fowls in the Upper Nile Province and arrangements have been completed by this Department to obtain and forward ten dozen eggs from nearly pure-bred English fowls for hatching purposes. It will be interesting to watch the progress of this experiment.

There is nothing of interest to report in connection with the breeding of donkeys, sheep, goats or dogs.

SECTION IV.

MISCELLANEOUS.

Grazing and Watering Facilities for Livestock.

The partial failure of the rains in the Northern and Central areas of the country resulted in a great scarcity of water and grazing North of what is normally the twenty inches rainfall belt.

In Dongola Province the food shortage was due to the river failing to reach a level sufficiently high to flood areas which in normal years are cultivated. In order to keep the work oxen alive in that Province the Government grew forage on land irrigated by existing pumping stations.

Heavy losses were obviated in the Musmar district of the Red Sea Province through the temporary provision of water for the local livestock by the Railway Authorities.

In the Provinces of Kassala, Blue Nile, Khartoum, White Nile, Kordofan and Darfur grazing and water were so scanty on the Northern grazing grounds that these were visited by the nomads for a very short period only and when they all fell back south on permanent waters the congestion was so great that their livestock had to travel long distances to graze or water.

In Kassala Province the efforts which have been made by the Administration during the year to conserve water by cleaning out old native reservoirs and by digging wells and new reservoirs are

very praise worthy. If these wells and reservoirs are kept in repair they will prove of great benefit to the people not only by enabling them to graze down the areas around them with their stock but, also, by enabling them to stay long enough in these areas to harvest any crops sown.

Several deep bores have recently been put down in Kordofan Province and these should greatly facilitate animal transport in certain areas.

Livestock in Relation to Cotton Production.

The feeding and manurial experiment conducted in connection with the Gezira canalization scheme and which was referred to in last year's Report is still in progress but it is hoped that it will be possible to furnish a report on this subject shortly.

Buildings.

Considerable improvements have been carried out in the Veterinary Research Laboratory building. These include the provision of a room specially fitted for work in connection with diseases readily communicable from animals to man such as rabies, anthrax and Malta fever.

Two loose-boxes and an operating shed have been erected in the Kassala Veterinary Hospital during the year and the new Veterinary Hospital at Wad Medani will soon be ready for occupation.

The Government Entomologist is preparing a brochure on the ticks of this country and their identification which will prove of great value to Veterinary Inspectors in carrying out their duties and this Report may be fittingly concluded by recording the debt of gratitude this Department owes to the Director of the Wellcome Tropical Research Laboratories and his staff for the assistance so freely rendered by them at all times in this and other connections.

Khartoum.

W. KENNEDY,

2nd February, 1927.

Director, Veterinary Department, S.G.

**REPORT OF THE VETERINARY RESEARCH OFFICER,
SUDAN GOVERNMENT.**

For the period 1st October, 1925 to 31st December, 1926.

(a) ROUTINE EXAMINATION.

During the period, 907 Smears and Specimens have been examined and reported on, excluding the examinations carried out in the course of research work.

Horses.

Piroplasma caballi	...	...	...	...	...	9
Nuttallia equi	...	...	...	...	...	3
Trypanosomiasis	...	...	...	...	...	8
Epizootic Lymphangitis	...	...	...	...	...	13
Ulcerative Lymphangitis	...	...	...	...	...	5
Pyogenic infections	...	...	...	...	...	17
Habronemic Granuloma	...	...	...	...	...	3
Filariasis	...	...	...	...	...	6
Spirochaetosis	...	...	...	...	...	1
Sarcosporidiosis	...	...	...	...	...	1
Negative	...	...	...	...	...	148

Mules

Trypanosomiasis	...	...	...	...	...	2
Epizootic Lymphangitis	...	...	...	...	...	47
Ulcerative Lymphangitis	...	...	...	...	...	5
Pyogenic infections	...	...	...	...	...	17
Negative	...	...	...	...	...	49
						— 120

Donkeys.

Piroplasma caballi	...	...	...	...	...	2
Epizootic Lymphangitis	...	...	...	...	...	3
Pyogenic infections	...	...	...	...	...	1
Filariasis	...	...	...	...	...	1
Rabies	...	...	...	...	...	1
Negative	...	...	...	...	...	32

Camels

Trypanosomiasis	...	...	...	...	...	26
Pyogenic infections	...	...	...	...	...	4
Filariasis ...	...	...	...	...	...	1
Dermoid Cyst	...	...	...	...	...	1
Rabies	...	...	...	...	...	1
Negative	...	...	...	...	...	197
						230

Cattle.

Piroplasma bigeminum	...	...	...	...	...	3
Theileria mutans	...	...	...	...	...	18
Trypanosomiasis	...	...	...	...	...	17
Anaplasmosis	...	...	...	...	...	3
Contagious Bovine Pleuro-Pneumonia				...	...	5
Pyogenic infections	...	...	...	...	...	5
Anthrax	...	...	...	...	...	3
Rabies	...	...	...	...	...	1
Spirochaetosis	...	...	...	...	...	1
Negative	...	...	...	...	...	156
						212

Sheep.

Negative	...	...	...	...	...	10
						10

Dogs.

Piroplasmosis	...	...	...	...	...	2
Sarcoma	...	...	...	...	...	1
Rabies	...	...	...	...	...	1
Negative	...	...	...	...	...	40
						44

Fowls.

Spirochaetosis	...	...	...	...	...	8
Mange	...	...	...	...	...	1
Negative	...	...	...	...	...	7
						16
Miscellaneous negative examinations	...	...	...	...	...	19
						19
						—
TOTAL	...	...	...	...	...	907

(b) REVIEW OF DISEASES.

Trypanosomiasis.

(1) Camels.

During the period under review the treatment of large numbers of camels, suffering from Trypanosomiasis, by Naganol, has been carried out. It is thought to be unnecessary to record the work in detail in this report, as the complete work will shortly be published.

In my Annual Report for 1925 I concluded that the Formol-gel test was a practical test for the diagnosis of Trypanosomiasis of camels and that Naganol 10 grammes employed as a single dose intravenously, in 10 per cent. aqueous solution, was a specific in the treatment of the disease.

The results of the treatment are as follows :—

Camels of the Sudan Defence Force.
(a) No. 2 and No. 4 Coys., Camel Corps, Bara.

It was decided to treat all camels of these two companies which were clinically affected with Trypanosomiasis.

Together with the Principal Veterinary Officer, I selected 114 out of a total of 425 camels as presenting clinical symptoms of the disease, and these were treated in November, 1925. After November, 1925, a further 27 camels became clinically affected and were treated.

Twenty-two of the 114 camels treated in November, 1925, were diagnosed microscopically.

The results of this treatment have been very satisfactory. The results as judged by the condition of the treated camels after four and a half months are shown in Table (A). It should be mentioned that during this period the companies were on patrol and subjected to fairly severe work.

TABLE (A).

Condition of camels clinically affected with Trypanosomiasis before and after treatment.

DATE.	Very poor.	Poor.	Fair.	Good.	Died.	Total.
Before treatment Nov., 1925	14	66	34	—	—
After treatment March, 1926	—	5	61	39	9	114

The camels of these two companies were again inspected in December, 1926, and the condition of the camels is shown in Table (B).

TABLE (B).

Condition of camels at Bara in December, 1926.

Very poor.	Poor.	Fair.	Good and very good.	Total.
2	—	11	395	408

It will thus be seen that whereas in November, 1925, there were 114 camels in an unsatisfactory condition, in December, 1926, there were 13, the camels being under identical conditions.

(b) No. 1 Co., Camel Corps, El Obeid.

This unit had suffered a high percentage of annual losses.

The establishment of this unit is 34 camels, but owing to heavy losses it was difficult to keep it up to strength.

It was decided to treat all the camels of this unit with Naganol and to observe the effect on the mortality.

The strength of the unit in November, 1925, was 23 camels, all of which received 10 grammes of Naganol. Another camel drafted to this unit was treated in March, 1926.

The effect of this treatment on the mortality, in comparison with the losses of the four previous years is shown in the following Table (C).

TABLE (C).

Annual losses of camels of No. 1 Co., Camel Corps, El Obeid.

YEAR.							Mortality from all causes.
1922	....	....	....	....	....	....	28
1923	....	....	....	....	....	....	7
1924	....	....	....	....	....	....	23
1925	....	....	....	....	....	....	15
1926 (After treatment)	....	....	....	....	....	....	4

It will be seen from the above table that the annual average loss of camels from all causes for four years preceding treatment was 18, whereas for the year after treatment the loss was reduced to 4.

The following Table (D) shows the total losses of the camels in the Camel Corps for the three years proceeding treatment and for the year 1926, after treatment. The losses include those from Trypanosomiasis and from other causes, but undoubtedly many of the losses shown under "other causes" are due directly or indirectly to Trypanosomiasis.

TABLE (D).

Losses of camels in Camel Corps, S.D.F.

YEAR.		Losses from Tryps.	Losses from Other Causes.	Strength of Camel Corps.
1923	....	....	52	63
1924	....	....	53	76
1925	....	....	49	150
1926 (After treatment)	....	8	55	514

It will be seen that the average annual loss from Trypanosomiasis for the three years preceding treatment was 51 camels, whereas the loss for the year after treatment was eight. The work of complete eradication of Trypanosomiasis from the Camel Corps by the Formol-gel test and Naganol has not been undertaken. It is confidently predicted that the losses of the camels can be brought to a very low figure.

(c) Camel Coy., Eastern Arab Corps, Kassala.

It was decided to attempt complete eradication of Trypanosomiasis from the camels of this company by first detecting all cases of Trypano-

somiasis by the Formol-gel test, and then by treating them with Naganol, and also treating twelve cases with a combination of Naganol and Antimony Potassium Tartrate.

In February, 1926, all the camels of this unit, totalling 196 were subjected to the Formol-gel test and it was found that 74 gave a positive reaction.

A single microscopic examination of the 74 reactors showed the presence of trypanosomes in 17.

Twelve of these 17 were treated with Naganol and Ant. Pot. Tart., and are shown in Appendix 1.

Of the remaining 62 camels, 60 were treated with a single injection of Naganol, 10 grammes, and two were cast for reasons other than Trypanosomiasis.

Of the total 72 camels treated, 3 were later destroyed for reasons other than Trypanosomiasis and one died with extensive abscess formation, and the other (353) was destroyed owing to abscess formation in the lungs (see Appendix 1).

The following table (E) shows the summary of the condition of the 67 treated camels remaining, before and 9 months after treatment.

TABLE (E).

DATE.	Poor.	Fair.	Good.	Total.
February, 1926, Before treatment	20	29	18	67
October, 1926, After treatment	0	5	62	67

The losses of camels by this Company in previous years have been heavy. In addition to the losses sustained throughout the year it has been necessary to destroy several camels at the end of the rainy season for Trypanosomiasis.

Thus after the rainy season of 1924, 13 camels and of 1925, 14 camels were destroyed in an advanced stage of Trypanosomiasis, whereas this year not a single camel was destroyed for the disease and no cases have been detected.

The beneficial effects of the eradication of Trypanosomiasis from the Camel Company at Kassala and of the partial eradication from the Camel Corps in Kordofan, will be felt for some time, extending over a year or two, as the reservoir, represented by the infected camels has been reduced.

In addition to the marked increase in efficiency of the Camel Companies S.D.F., by this work, the estimated saving is over £E. 3,000.

Camels of Civil Departments.

The heaviest losses in the camels occurred in Kordofan Province. It was decided to give all the camels of the Officials and Police in Kordofan a single dose of Naganol, 10 grammes, and to observe the effect on the mortality and on the compensation.

From November, 1925, to February, 1926, 329 camels were treated. I have only the returns of the compensation paid up to the end of July.

This year the total compensation paid in Kordofan up to the end of July was £E. 922 as compared with £E. 1,159 in the corresponding period of 1925, showing a reduction of £E. 237 in 1926, although the establishment of camels was considerably increased.

Diagnosis.

Further observations on the Formol-gel test have been carried out.

The following conclusions have been made :—

- (i) That the Formol-gel test is a practical test for the detection of Trypanosomiasis of camels.
- (ii) That it enables one to detect the disease in all its stages, except for a period of 6 to 7 weeks after infection.
This has to be borne in mind in formulating measures for the eradication of the disease.
As the period of infection is during the rains and just after the rains, the test should not be applied before November.
- (iii) That a small percentage of healthy camels give a reaction to the test, which in this case is of a temporary nature and these are called "Temporary Reactors." In measures for eradication of the disease, these healthy camels would also be treated but as the treatment is harmless, the error is on the safe side and the small cost of the treatment of these "Temporary Reactors" is the only drawback.
- (iv) That certain other diseases of camels (3 cases detected) can also cause a positive reaction to the Formol-gel test but that these diseases are of such infrequent occurrences in the Sudan, that they may be ignored in measures undertaken for the eradication of the disease.
- (v) That camels cured of the disease become negative to the Formol-gel reaction in from 6 to 7 weeks.

Immunity.

A preliminary experiment recorded in my annual report for 1925 showed that immunity was acquired by camels cured of Trypanosomiasis by Naganol.

Further experiments have been carried out and are shown in Appendix II.

It is shown that camels cured of Trypanosomiasis by Naganol have a definite immunity against the disease, that this acquired immunity may be relative or absolute and that it is of long duration.

It is found that this immunity serves to protect camels against developing the disease even when kept in infected areas.

Experiments are now in progress to investigate measures for the artificial immunization of healthy camels against Trypanosomiasis.

*Test of Susceptibility of Camels to *Trypanosoma pecaudi*.*

Although all cases of Trypanosomiasis of camels diagnosed have been caused by *Tryp. soudanense*, the possibility of infection with other trypanosomes had to be considered. As camels were required for the work of transportation of cotton in areas in the Nuba Mountains Province, where *Glossina morsitans* exist, it was decided to test the susceptibility of camels to *T. pecaudi*.

Both mules and horses become infected with *T. pecaudi* in these fly areas.

A normal camel, No. 5, was proved to be free from Trypanosomiasis by microscopic examination, animal inoculation and the formol-gel test. It was inoculated subcutaneously with 2 c.c. citrated blood containing *T. pecaudi*, on 28.4.26. On 4.5.26 *Tryp. pecaudi* appeared in the blood and was continuously present, becoming very numerous in 7 days. The camel rapidly lost condition, had continual fever and showed symptoms of acute Trypanosomiasis.

On 13.6.26 it was positive to the Formol-gel test.

On 16.6.26 it was treated with Naganol, 10 grammes.

After treatment trypanosomes did not appear in the blood, the blood was negative to animal inoculation, became negative to the Formol-gel test and the camel improved in condition. These observations were continued for 6 months and it was concluded that the camel was cured.

Conclusion.

- (i) That camels are susceptible to *T. pecaudi*.
- (ii) That Naganol also cures *T. pecaudi* infection in camels.

This later conclusion is of interest because it is shown later that mules naturally infected with *T. pecaudi* were not cured by Naganol.

(2) Horses.

Eight cases of Trypanosomiasis have been diagnosed in horses. Two were due to *T. pecaudi* and six to *T. congolense*, all came from Kordofan and Nuba Mountains Province. Attempts at treatment of two horses infected with *T. congolense* by Naganol were unsuccessful.

(3) Mules.

Two cases of Trypanosomiasis of mules were diagnosed, both due to *T. pecaudi*. They were from Kordofan. Attempts at treatment with Naganol were unsuccessful.

(4) **Donkey.**

Two cases of Trypanosomiasis of donkeys due to *T. pecaudi* were diagnosed. They were in the Bahr-el-Ghazal Province.

(5) **Cattle.**

Seventeen cases of Trypanosomiasis of bovines were found as follows :—

4 Kordofan Province in A T. Corps	....	T. congolense.
8 Fung Province	....
1 Port Sudan Quarantine Park	....
1 Halfa Quarantine Park	....
1 Khartoum Abbatoir	....	<i>T. vivax</i>
1 Fung Province	....	Type not determined
1 Mongalla Province	....

Contagious Bovine Pleuro-Pneumonia.

Studies in this disease have been continued. The work is recorded in Appendix III.

It has been found that the vaccine against the disease can be employed as a single dose instead of two doses, and that non-virulent strains of the virus can be employed for vaccine production without interfering with their efficacy for the production of immunity.

During the year, 4,250 doses of the vaccine have been issued to the Provinces.

The following is an abstract of the reports of Capt. F. J. Andrews, the Veterinary Inspector of Blue Nile, on the vaccination of the cattle on the Gezira.

ANIMALS VACCINATED.

Working Bulls	....	....	....	....	1,648
Cows and calves	....	....	....	....	127
TOTAL	....	....	....	....	1,775

Out of this total two severe reactions are recorded as follows :—

- (i) An extensive swelling occurred extending over the shoulder and into the dewlap. The bull was destroyed, and on incision the swelling presented the appearance of a typical Pleuro-pneumonia tumour.
- (ii) Developed a large swelling at the site of inoculation which burst and afterwards healed. The bull made a good recovery.

Statistics are not available to show the effect of the vaccination on the incidence of Contagious Bovine Pleuro-pneumonia but it is thought that the results are very beneficial.

Rinderpest.

During the season the work has consisted chiefly of testing samples of serum produced at Khartoum and purchased from Eritrea.

Of two large consignments from Eritrea the first was found to prevent severe symptoms at a dose of 50 c.c. per 600 lbs. body weight (8.3 c.c. per 100 lb.), but smaller doses were not capable of preserving life.

The same dose of the second consignment allowed very severe reactions to develop on testing in the same way. As the first consignment appeared to be imperfectly preserved, bacterial counts were made on a few bottles selected at random and these were found to contain from 15,000,000 to 160,000,000 living organisms per 1 c.c.

A sample of serum prepared at this laboratory last year and stored for fourteen months was also tested and found to be capable of preserving life at 35 c.c. per 600 lb. and of preventing severe symptoms in 50 c.c. doses. The serum had deteriorated by approximately 25 per cent. after a year's storage.

A preliminary experiment was also conducted on the possibility of preparing a potent anti-serum without hyper-immunization—the "Philippine" method. Owing to the impossibility of obtaining sufficient suitable bulls for testing separate bleedings at different intervals after immunisation, a single test was performed on a mixture of sera taken from five bulls at one, three, five and seven weeks after cessation of temperature reaction. This combined serum was found to be useless even in doses of 75 c.c. per 600 lb. body weight. The method is to be further studied.

Rabies.

An outbreak of Rabies occurred in Kordofan in the early part of the year, and examination of suspected material was carried out in co-operation with the Wellcome Tropical Research Laboratories.

All positive diagnoses were made in specimens from the El Obeid District and two "strains" of the virus were studied in this laboratory. The results were interesting in that the virus on rabbit passage behaved similarly to some viruses studied in the French West African Colonies, where it has been suspected that such viruses are not transmissible to man. In the Sudan outbreak, human cases were recorded and it seems that in this part of the world too much reliance should not be placed on the behaviour of a rabies virus in rabbits as a guide to its range of pathogenicity.

Anthrax.

During the period under review three cases have been diagnosed, all occurring in cattle.

Two occurred at the Old Quarantine at Shambat. One occurred at the New Quarantine Park at Khartoum North.

Anthrax vaccines were prepared from strains of the anthrax bacillus obtained from the Research Laboratory of the Government of the Union of South Africa.

These were spore vaccines. They were tested at the laboratory and 1,000 doses were issued.

It has not been found necessary to use them.

Extension of Laboratory.

With the extension of the work and staff, it was found that the existing laboratory and office accommodation was insufficient. The

laboratory has this year been extended, four additional rooms which were below the existing laboratory have been converted into laboratories and completely equipped.

One room has been specially fitted and equipped for work in connection with the diseases communicable from animals to man, such as rabies, anthrax, Malta fever, etc.

Library.

During the year the library has been arranged and indexed, and a large number of new books obtained. This work was carried out by Mr. S. C. J. Bennett.

Staff.

Mr. S. C. J. Bennett, B.Sc., the Assistant Veterinary Research Officer, who arrived in September, 1925, has quickly acquired an intimate knowledge of local diseases and conditions. He has given invaluable help in the researches indicated in this report, and enabled me to be absent on Trypanosome work without interruption of the investigations.

Mr. P. A. C. Kenny, the Laboratory Assistant, has again carried out his work very satisfactorily.

Major R. G. Archibald, D.S.O., the Director of the Wellcome Tropical Research Laboratories, has continued to take a keen interest in the work of the laboratory and it is hoped that co-operation between the medical and veterinary research workers will become closer, and so follow the lead given at home and in the colonies.

(Sgd.) R. H. KNOWLES, Major, R.A.V.C.,
Veterinary Research Officer, Sudan Government.



APPENDIX I.

TREATMENT OF TRYPANOSOMIASIS OF CAMELS WITH A COMBINATION OF NAGANOL AND ANTIMONY POTASSIUM TARTRATE.

The results of the treatment of Trypanosomiasis with Naganol were regarded as satisfactory, but on the grounds of economy it was decided to explore the possibilities of employing a small dose of Naganol combined with Ant. Pot. Tart.

It may be stated that 10 grammes of Naganol costs approximately P.T. 54, so that the cure of a camel suffering from Trypanosomiasis, at that cost, is a decidedly economic proposition.

I am not aware that a combination of Naganol and Ant. Pot. Tart. has been employed in the treatment of Trypanosomiasis of camels, although these drugs have been employed together in the treatment of the disease in other animals.

Berg, working in South Africa, states that a combination of these two drugs gives good results in the treatment of Nagana.

Hornby and Burns, however, found that no advantage was obtained by using a combination of these two drugs, over the use of Ant. Pot. Tart. alone, in the control of infection of cattle with *T. congolense* and *T. vivax*.

The results obtained by the treatment of Trypanosomiasis of camels by a combination of Naganol and Ant. Pot. Tart., are shown in Table I.

It is known that the intravenous administration of Ant. Pot. Tart. to camels affected with Trypanosomiasis causes a rapid destruction of the trypanosomes present in the circulation, and that if the trypanosomes are numerous in the blood at the time of the injection, their destruction is followed by severe toxic symptoms which have been known to prove fatal.

The toxic symptoms are thought to be due to either a rapid liberation of toxins from the destroyed trypanosomes, or occlusion of the blood capillaries by the dead trypanosomes.

In order to observe the effects of the administration of Ant. Pot. Tart. the blood of the camels treated was examined just before the injections, and the effects noted.

Reference to Table I shows that the toxic symptoms produced were proportionate in severity to the numbers of trypanosomes present in the circulation at the time, with the exception of camel 235, which had slight toxic symptoms although trypanosomes were very numerous.

The toxic symptoms produced were as follows :—

In severe reactions the symptoms were of an alarming nature, and supervene two or three minutes after the administration of the drug.

There is uneasiness and colic, straddling of the legs and incoordination of movement. Salivation and regurgitation. Defaecation and diarrhoea with mucous stained faeces. Frequent urination and straining. Laboured respirations. Sometimes the camel lies down, or falls down, and rests the head on the ground, moaning, and appears to be semi-comatose.

The symptoms pass off in from ten to thirty minutes. No toxic symptoms were produced in camels which showed few or no trypanosomes in the blood at the time.

In adopting this method of treatment, involving the use of Ant. Pot. Tart., it will therefore be necessary to examine the blood at the time of treatment, and if trypanosomes are numerous to wait until they disappear or become scanty in numbers. As an alternative the administration of the Ant. Pot. Tart. the day after may be tried.

Reference to Table 1., shows the results obtained by the treatment of fourteen camels affected with Trypanosomiasis.

Camels 457 and 473 were treated at the Veterinary Research Laboratory and were kept under daily observation for four and a half months. They made a good recovery and were negative to the animal inoculation.

They returned to work and were examined at the end of eleven and a half months and ten and a half months respectively. They were in good condition and negative to the Formol-gel test.

These two camels were selected as advanced cases of Trypanosomiasis, to test the efficacy of this form of treatment, at the Veterinary Research Laboratory.

The remaining twelve camels shown in Table 1., were selected from the camels diagnosed microscopically at Kassala.

It will be seen that nine months after treatment all except 353 were negative to the Formol-gel test. Ten has returned to good condition, one (257) had improved from very poor to fair condition.

The history of camel 353 shows that three months after treatment it was negative to the Formol-gel test, again becoming positive and losing condition.

It was shown to be cured of Trypanosomiasis by microscopic examination and animal inoculation. Post mortem examination showed extensive abscess formation in the lungs and peritoneum, the pus of which abscess contained corynebacterium in pure infection, which condition caused the loss of condition and the positive reaction to the Formol-gel test.

It will be thus seen that, excluding camel 353, thirteen camels treated with a combined single dose of Naganol and Ant. Pot. Tart. in the doses shown, all became negative to the Formol-gel test and all returned to good condition and remained so up to nine months after treatment.

It will perhaps be advisable to carry on more extended observations on this combined treatment before making definite conclusions, but it appears that this treatment in the doses shown is as efficacious as the treatment with Naganol alone, and has the advantage of costing less than half the price.

Observations on the treatment of Trypanosomiasis of camels by a combination of Naganol and Ant. Pot. Tart. have been commenced, but have not advanced far enough to record.

APPENDIX II.

IMMUNITY OF CAMELS CURED OF TRYPANOSOMIASIS.

It is known that certain animals recover from infection with trypanosomes, and that after recovery such animals are found to be resistant to reinfection with the same trypanosomes. They are, however, still susceptible to infection with other trypanosomes, and so the immunity acquired is specific.

Leckie working on the treatment of Surra in camels in India with Ant. Pot. Tart. states that there would appear to be little or no protection gained after being cured from the first attack.

I am not aware of any controlled experiments to test the immunity of camels after cure of Trypanosomiasis.

It was obvious that if, in addition to the cure of camels by Naganol, an immunity against reinfection was obtained, the value of the camel would be considerably increased and it would be possible to work camels in dangerous fly areas without fear of infection.

Experiments were therefore carried out to test if camels, cured of Trypanosomiasis by Naganol, were immune to reinfection by inoculating them with citrated blood from camels in the acute stage of the disease naturally contracted, and having trypanosomes numerously present in their blood at the time. At the same time normal control camels were infected with blood from the same infected camels.

The control camels were proved to be free from Trypanosomiasis by microscopic examination, animal inoculation and Formol-gel test.

The camels, both treated and controls, were inoculated subcutaneously with 3 c.c. of citrated blood from natural cases of the disease.

The results of these immunity experiments are shown in Table II.

Camel 1052 was a camel cured of Trypanosomiasis.

Camels 49 and 75 were controls to camel 1052.

Camel 1 was a camel cured of Trypanosomiasis.

Camel 6 was the control to the 1st reinfection, and Camel 8 was the control to the 3rd reinfection of Camel 1. No control was used to the 2nd reinfection.

Camel 1630 was a camel cured of Trypanosomiasis.

Camel 6 was the control to the 1st reinfection of Camel 1630. No control was used to the 2nd reinfection.

It will be seen from Table II that camel 1052 after inoculation with trypanosomes became infected, but that trypanosomes did not appear in the circulation until the 23rd day, whereas the two controls, 49 and 75, showed trypanosomes in the circulation on the 8th and 7th day respectively. Although trypanosomes continued to appear in the blood of camel 1052 at intermittent periods, the disease produced no symptoms and the camel remained in good condition. The camel was kept under observation for over three months, when it was destroyed for old age.

Camel 1052 developed a reaction to the Formol-gel test. It will be noted that the immunity was tested nine and a half months after treatment.

Camel 1 was reinfected on three separate occasions as shown, and was kept under observation up to December, 1926, i.e. twelve months after the first reinfection. Trypanosomes never reappeared

in the circulation and it remained negative to animal inoculation and to the Formol-gel test throughout. The immunity of this camel was tested nine and a half, ten and a half, and twenty months after treatment.

Camel 1630 was reinfected on three separate occasions. After the first reinfection trypanosomes appeared in the blood stream on the 3rd day and were present for four days. After this they did not appear again, although observations were carried out for ten months.

They did not appear after the 2nd reinfection. Animal inoculations on gerbils and a dog were carried out as shown in the table but remained uninfected. The camel was negative to the Formol-gel test throughout and it continued to improve in condition.

The immunity tests of 1630 were carried out six weeks and three and a half months after treatment.

In marked contrast to the treated camels, the controls 49, 75 and 6 all became infected and developed an acute type of Trypanosomiasis.

The other control, camel 8, showed trypanosomes in its blood on the 11th day and were very numerous on the 13th day. The attack was, however, cut short by treatment with Naganol as this camel was being employed in another immunity experiment.

Thus it will be seen that the camel 1052 showed trypanosomes in the circulation, and developed a positive reaction to the Formol-gel test, but developed no symptoms of the disease. It remained in good condition, and had an immunity comparable to those natural cases of the disease which are said to recover, but which are more probably only in the chronic stage of the disease, and continue to harbour trypanosomes, and give a positive reaction to the Formol-gel test.

On the other hand camels 1 and 1630 had an absolute immunity against the disease, as trypanosomes did not appear in the blood (disregarding the transient appearance in 1630), and the blood remained negative to the Formol-gel test, and to animal inoculation.

These tests indicate that the Formol-gel test can be used to ascertain whether the immunity thus acquired is relative or absolute, for whereas camel 1052 with a relative immunity, developed a reaction to the test, Camels 1 and 1630, with an absolute immunity sufficient to bring about destruction of the inoculated trypanosomes and also any which multiplied for a short time in the blood as in 1630, did not develop the reaction to the Formol-gel test.

The immunity acquired seems to be of long duration, for camel 1 was tested twenty months after treatment.

If, however, we regard there infection in the first immunity test as a reinforcing of the immunity, the duration of the immunity of camel 1 would be nine and a half months.

On the other hand if these reinfections can be regarded as reinforcing it follows that cured camels kept in infective areas will probably be reinforced from time to time, and so the duration of the immunity continually extended.

That acquired immunity is either of long duration, or continually reinforced, is supported by the observations on the camels treated.

As an example take the twelve camels treated in December, 1924, and shown in Table I, Appendix I, of my Annual Report for 1925.

Two years after treatment these twelve camels have remained uninfected, are still negative to the Formol-gel test and in good condition, and have been at work all the time. They have been continu-

ously in contact with camels suffering from Trypanosomiasis in their own Companies. That they have had opportunity of reinfection is proved by the fact that many of the remount camels issued to the Companies since these camels were treated have become infected with Trypanosomiasis.

These immunity tests prove conclusively that camels, suffering from Trypanosomiasis and cured by Naganol, have a definite immunity against the disease, the degree of which immunity varies in individual camels.

The studies of Kliger and Weitzman carried out in Palestine on this subject is of special interest as they were worked with *T. evansi* and Bayer 205.

They employed laboratory animals, rabbits, infected with *T. evansi* and treated with Bayer 205.

They concluded that infected animals cured with Bayer 205 acquire an absolute resistance of greater or lesser duration to a reinfection, and they show that this resistance is of much longer duration than that of normal control animals treated with corresponding doses of Bayer 205.

In a later work Kliger and Weitzman show that the repeated injection of animals with dead, whole or autolysed trypanosomes fails to increase the resistance of the animal to infection, but on the contrary renders them hyper-sensitive, with a more rapid invasion of the peripheral circulation after infection, and a more rapid appearance of the symptoms of the disease.

On the other hand they found that animals treated with a suspension of trypanosomes in Bayer 205, instead of becoming hyper-susceptible, develop a resistance quite distinct from that induced by the same quantity of Bayer 205 alone.

Certain information on this subject can be deduced from the immunity experiments recorded here.

It has been shown that camels suffering from Trypanosomiasis and cured by Naganol have a definite immunity against the disease.

If we accept the view expressed by Leckie that camels suffering from Trypanosomiasis and cured with Ant. Pot. Tart. do not acquire immunity, it shows that Naganol plays some specific role in the production of this immunity.

It would appear that for the production of immunity it is not sufficient to only employ a trypanocidal agent, but to employ one such as Naganol which has, in addition to the trypanocidal some specific immunity-producing properties.

We must conclude that there is a combination between the Naganol and the protoplasm of the trypanosome cell, thus producing a heterogenic antigen, which is capable either of stimulating the formation of specific antibodies or of causing changes in the animal mechanism, which enables the cured animals to resist infection.

APPENDIX III.

SUMMARY OF EXPERIMENTS ON CONTAGIOUS BOVINE PLEURO-PNEUMONIA AT THE VETERINARY RESEARCH LABORATORY.

The experiments conducted on Contagious Bovine Pleuro-pneumonia have been in continuation of those recorded in last year's report and have been mainly concerned with the evolution of a safe vaccine which shall be easily prepared and given in the field as a single dose. In working towards this main objective several of the minor properties of the pleuro-pneumonia virus have necessarily engaged attention and the studies may be approximately classified as follows :—

- (i) Attempts to produce a culture medium more easily and cheaply prepared than the classic "Martin's Broth."
- (ii) Observations on the loss of virulence of the virus in artificial culture media.
- (iii) Comparative studies of different "strains" of the virus.

(i) *Cultivation of the Virus.*

The preparation of "Martin's" broth is a lengthy and inconvenient process since the ingredients must be maintained at a fixed heat for several hours. With the apparatus available this process was expensive on the count of fuel and in addition, being made from pigs' stomachs, there was always the danger that the supply of these would fail. It was difficult to understand *a priori* why "Martin's" peptone should be better than the well-known commercial peptones and experiments with a number of the latter have shown that any of them can replace stomach autolysate, and that they are even better. In short, the culture medium that is now exclusively used in this laboratory is virtually nothing more than the plain broth universally employed in bacteriology but containing two per cent. of commercial peptone instead of the usual one per cent. As with "Martin's" broth ten per cent. of sterile serum is added to the sterilized medium, and it has been found that horse serum permits better growth than ox serum.

In regard to the isolation of the virus in primary culture the new medium is greatly superior to the original, luxuriant growth being obtained within twenty-four hours. New strains are being isolated from time to time in order to obtain a series of cultures of various ages to be tested as to their suitability as vaccines.

(ii). *Attenuation of Virulence in Artificial Culture.*

No experiments have been designed with the primary object of studying this question, since it is already known that after a sufficient number of sub-cultivations the virus loses its power to provoke any serious disturbance when injected into susceptible animals. In the tests of experimental vaccines, however, it has been observed that five strains of culture virus ranging from the 13th to the 66th generations in the new medium were all similar in that absolutely no reaction developed in cattle receiving 2 c.c. doses of living culture. Further, as will be shown in detail in reporting on the vaccine tests, there appeared to be no difference in the protective powers of the strains (see Table IV).

(iii) *The Comparative Study of Different Strains.*

Very little work has been done on these lines. In the first place, although one may isolate the virus in culture from diseased animals in various places, it is not certain that the infections did not originate in a common locality; in fact our local knowledge makes it seem probable that there is for practical consideration only one source. Thus, that most or all of the strains hitherto studied have behaved similarly does not necessarily indicate that there is only one type of virus in the Sudan. In fact, in one vaccine test (see Table IV) the virus used for testing was the pleuritic exudate from a natural case but in both of the controls in the test an atypical reaction developed on subcutaneous inoculation. It is, however, to be noticed in this test that the vaccinated cattle which had earlier received cultures of what may for convenience be called "typical" strains were immune to the "atypical" test virus. This result is encouraging, but it will be necessary to make further observations as to the possible existence of immunologically different strains.

THE VACCINES.

Two main vaccine tests were carried out, the first with two strains maintained in culture in "Martin's" broth for about nine months and the second with five strains varying from about three months to sixteen months in age in artificial culture. The older ones had been cultivated first in "Martin's" broth and later in plain peptone medium, while the younger ones had been cultivated only in the latter. It is not intended to discuss the tests at great length as it is intended shortly to submit a full publication for reproduction in a scientific journal. The essential results are here shown in Tables III and IV. All doses of vaccine were subcutaneous and the test virus was 2 c.c. of fresh lymph from the lung or pleura of a natural case.

It is not necessary in this report to make more than a brief mention of another test carried out on the lines of that shown in Table II. Here a single dose vaccine was under test but the virus, taken from the lung of a natural case, was contaminated with bacteria. Further, the vaccinated animals were tested only a fortnight after vaccination. Some of the vaccinated animals developed atypical swellings which on exploratory puncture proved to contain corynebacteria. Two bulls were examined in this way and the bacterium recovered was the same morphologically and culturally in each case; one swelling burst and the bull made an immediate recovery. On the other hand, one vaccinated bull died and on P.M. a typical "pleuro-pneumonia tumour" was seen. Having regard to all circumstances the results of the tests were almost useless except to indicate that in future tests it would be preferable to use a virus that had been "passaged" at least once and found to be pure.

Referring again to the tests summarised in Tables I and II it is seen that in the first test a single larger dose of vaccine proved to be as effective as two graded doses and that there was no necessity to vaccinate in the tail. That two vaccinated bulls showed some susceptibility when tested may have been due to the unsuitability of the strain of culture virus or, more probably, to the fact that they were tested too soon after having been vaccinated. The date for testing was arbitrarily chosen since no information is available as to the

length of time required for a solid immunity to develop. Experiments are now in progress with the object of clearing up this point.

In the second test the usefulness of the virus in plain peptone medium is demonstrated. No vaccinated animal showed more than mild symptoms while of two controls one died and the second all but did so. One has thus advanced far in the direction of producing a cheap, easily prepared and protective vaccine which shall be effective when given as a single dose.

CONCLUSIONS.

Briefly stated, the conclusions arrived at in the course of the year are :—

1. For cultivation of the virus it is not necessary to make "Martin's" broth since a plain peptone broth seems to be equally suitable.
2. As a vaccine the virus grown in plain peptone broth is both safe and efficient.
3. A single dose (2 c.c.) of culture either in "Martin's" broth or plain peptone broth protects against later injection of virulent lymph.
4. It seems not to be necessary for the vaccine to produce any systemic or local reaction.
5. The length of time that a virus has been maintained in artificial culture is probably of minor importance; no difference was observed in the behaviour of strains between the 13th and 66th generations.
6. It is estimated that about a month is required for a fairly solid immunity to develop; experiments are now in progress to settle this point.



TABLE I.

Fourteen camels treated with a single combined dose of Naganol and Antimony Potassium Tartrate.
All were diagnosed microscopically. Animal inoculations only on 457 and 473.

No.	Date of treatment.	Treatment.	Duration between treatment and final observation.	CONDITION			Tryps. at time of treatment.	Reaction to injection		
				Time of treatment.	Final observation.	Time of treatment.				
457	3.1.26 at Vety. Research Lab.	Naganol 3 grammes. Ant.Pot. Tart. 3 grammes.	11½ months	+	—	Poor	PP	Moderate		
473	27.1.26 at Vety. Research Lab.	Naganol 3 grams. Ant. Pot. Tart. 2 grammes.	10½ months	+	—	Poor	A	Nii		
311	Feb. 203 1926 at Kassala	Naganol 4 grams. Ant. Pot. Tart. 2 grammes.	9 months	+	—	Poor	A PPP A PP PPP PPP	Nil Severe Nil Severe Slight Severe		
203	Feb. 178 1926 at Kassala	Naganol 4 grams. Ant. Pot. Tart. 2 grammes.	9 months	+	—	Poor	A PPP A PP PPP PPP	Nil Severe Nil Severe Slight Severe		
178	Feb. 277 1926 at Kassala	Naganol 4 grams. Ant. Pot. Tart. 2 grammes.	9 months	+	—	Poor	A PPP A PP PPP PPP	Nil Severe Nil Severe Slight Severe		
277	Feb. 235 1926 at Kassala	Naganol 4 grams. Ant. Pot. Tart. 2 grammes.	9 months	+	—	Poor	A PPP A PP PPP PPP	Nil Severe Nil Severe Slight Severe		
235	Feb. 353 1926 at Kassala	Naganol 4 grams. Ant. Pot. Tart. 2 grammes.	9 months	+	—	Poor	A PPP A PP PPP PPP	Nil Severe Nil Severe Slight Severe		
353	Feb. 247 1926 at Kassala	Naganol 4 grams. Ant. Pot. Tart. 2 grammes.	9 months	+	—	V. Poor	P A A PPP P A	Nil Nil Nil Very severe Nil Nil		
247	Feb. 215 1926 at Kassala	Naganol 3 grammes Ant. Pot. Tart. 2 grammes	9 months	+	—	V. Poor	P A A PPP P A	Nil Nil Nil Very severe Nil Nil		
215	Feb. 372 1926 at Kassala	Naganol 3 grammes Ant. Pot. Tart. 2 grammes	9 months	+	—	V. Poor	P A A PPP P A	Nil Nil Nil Very severe Nil Nil		
372	Feb. 367 1926 at Kassala	Naganol 3 grammes Ant. Pot. Tart. 2 grammes	9 months	+	—	V. Poor	P A A PPP P A	Nil Nil Nil Very severe Nil Nil		
367	Feb. 301 1926 at Kassala	Naganol 3 grammes Ant. Pot. Tart. 2 grammes	9 months	+	—	V. Poor	P A A PPP P A	Nil Nil Nil Very severe Nil Nil		
301	Feb. 257 1926 at Kassala	Naganol 3 grammes Ant. Pot. Tart. 2 grammes	9 months	+	—	V. Poor	P A A PPP P A	Nil Nil Nil Very severe Nil Nil		
257	Feb. 247 1926 at Kassala	Naganol 3 grammes Ant. Pot. Tart. 2 grammes	9 months	+	—	V. Poor	P A A PPP P A	Nil Nil Nil Very severe Nil Nil		

P. Few present in blood. means one tryp. in every 3 or 4 fields, in moist preparation.

PP. Moderate number present, one or two tryps. to every field.

PPP. Numerous—more numerous than above.

A. Absent.

TABLE II.
IMMUNITY TESTS.

Re-infection of treated camels together with infection of healthy controls.

No. of camel.	Date of treatment.	Treatment with Naganol	Date of experimental infection.	Period for Tryps. to appear in circulation.	Period for Formol-gel to become positive.	Course of the disease.
1052	24.1.24 26.1.24 28.1.24	6 grammes 6 grammes 6 grammes	13.11.24	23 days	49 days	Remained in good condition. Tryps scanty. Slight fever.
49 Control		Nil	13.11.24	8 days	37 days	Developed acute Trypanosomiasis. Rapid loss of condition. Almost continuous fever. Tryps. very numerous in the blood almost and constantly present.
75 Control		Nil	13.11.24	7 days	+4 days	Remained in good condition. No fever. Gerbils inoculated 1.2.26, 10.4.26, 31.10.26, and 20.12.26. Remained uninfected.
1	29.11.24 18.3.25	6 grammes 10 grammes	2.1.26 1.2.26 15.11.26	Had not appeared up to December 20th, 1926	Renained negative up to December 20th 1926.	Improved in condition. Gerbils inoculated 10.4.26, 31.10.26 and dog inoculated 6.11.26 remained uninfected.
1630	19.11.25	10 grammes	2.1.26 7.3.26	3 days after 1st infection for 4 days and then blood remained free up to 6.11.26	Renained negative up to 6.11.26	Developed acute Trypanosomiasis. Rapid loss of condition. Tryps. very numerous.
6 Control		Nil	2.1.26	10 days	50 days	Almost continuous fever.
8 Control.		Nil	15.11.26	11 days		Tryps. very numerous on 13th day. Treated with Naganol 10 grammes.

TABLE III.

Vaccinations with one and two doses of culture virus, tested with natural lymph.

No. of Bull.	Date of first vaccine.	Strian and generation.	Site and dose.	Reaction.	Date of second vaccine.	Strain and generation	Site and dose.	Reaction.	Reaction to immunity test 1-11-25
39	5.10.25	35.	25th Shoulder 1 c.c.	Nil	—	—	—	—	Distinct thermal reaction. Considerable local swelling, commencing 14th day and resolved by 24th day.
45	5.10.25	35.	25th Shoulder 1 c.c.	Nil	—	—	—	—	No thermal reaction. Slight local swelling from 10th to 18th days.
42	17.9.25	3.	40th Tail 1 c.c.	Nil	—	—	—	—	No thermal or local reaction.
44	17.9.25	3.	40th Shoulder 1 c.c.	Nil	—	—	—	—	No thermal or local reaction.
41	17.9.25	3.	40th Shoulder 1 c.c.	Nil	10.10.25	3.	44th Shoulder 1 c.c.	—	No thermal or local reaction.
43	17.9.25	3.	40th Shoulder 1 c.c.	Nil	10.10.25	3.	44th Shoulder 1 c.c.	Nil	No thermal or local reaction.
47	Control		Nil	—	—	—	—	—	Slight local reaction, recovered
48	Control		Nil	—	—	—	—	—	Very severe fever, large local swelling. Killed in extremis on 18th day. On P.M. a typical "pleuro-pneumonia tumour" was found.

TABLE IV.

Vaccinations with one dose of culture virus, tested with natural lymph.

No. of Bull.	Strain and generation.	Date of vaccination.	Site and dose.		Reaction.	Reaction to immunity test on 31-5-26, virus 2 c. c. natural lymph in L. shoulder.
			R. shoulder	2 c.c.		
70	3. 66th	18.3.26	Nil	No thermal reaction. Slight local swelling 9th to 12th days.		
72	"	"	Nil	No thermal reaction. Slight local swelling 7th to 9th days.		
64	6. 16th	"	Nil	Mild fever 3rd to 8th days. Fairly painful local swelling 3rd to 12th days.		
68	"	"	Nil	Mild fever 6th to 9th days. Local swelling and lameness 5th to 14th days.		
66	7. 15th	"	Nil	No thermal reaction. Very slight local swelling 5th to 9th days.		
74	"	"	Nil	Mild fever 3rd to 8th days. Fairly painful local swelling 4th to 13th days.		
75	8. 16th	"	Nil	No thermal reaction. Very slight local swelling 5th to 9th days.		
77	"	"	Nil	? Pyrexia 5th to 13th days. Fairly painful swelling and lameness 7th to 14th days.		
78	9. 13th	"	Nil	No thermal reaction. Diffuse almost painless swelling without lameness 4th to 12th days.		
79	"	"	Nil	No thermal or local reaction.		
81	Control	"	—	Continuous fever 7th to 25th days. Moderately painful local swelling 7th to 25th days. Severe lameness, polyarthritis and anorexia, increasing up to 28th day. Gradual improvement thence to 40th day when bull was destroyed.		
82	Control	—	Nil	No positive P. M. findings.		
			—	Severe pyrexia from 4th day. Large painful swellings, polyarthritis and intense lameness. Local swelling extending down chest and brisket. Slaughtered in extremis 17th day. Typical "pleuro-pneumonia tumour" on P.M.		

